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# THE CAVERNICOLOUS FAUNA OF HAWAIIAN LAVA TUBES, PART VI. MESOVELIIDAE OR WATER TREADERS (HETEROPTERA)

Wayne C. Gagné and Francis G. Howarth

Department of Entomology
Bernice P. Bishop Museum
Honolulu, Hawaii 96818

ISLAND ECOSYSTEMS IRP

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ABSTRACT

This paper is a systematic report and a biological analysis of the Mesoveliidae from Hawaiian caves. Most important is a new species of Speovelia Esaki, S. sp. (Hawaii I.), described from material collected on moist walls in lava tubes. This apparently represents the world's first troglobitic heteropteran. Morphologically, all instars show lack of pigmentation, functionless eyes and prolongation of the appendages and head. Biologically, it is restricted to the dark zone of lava tubes. Notes on its biology are given. It also represents the first known endemic species of the family for the Hawaiian Islands. Another species, Mesovelia amoena Uhler, is troglophilic. This is the first record of this immigrant American species in the Hawaiian Islands. The remaining species in Hawaii, the immigrant M. mulsanti White, has only been found in epigean situations. A key to the species is also presented.

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# INTRODUCTION

The discovery of cave dwelling Mesoveliidae in Hawaii is particularly significant in several respects. Foremost, the presence of the troglobitic Speovelia sp., described below, in a lava tube on the island of Hawaii, marks the initial discovery of a true troglobitic Heteropteran for the world. Morphological features indicating this habit are those common to troglobitic arthropods: loss of pigmentation, reduction or loss of eyes, elongation of appendages. This is correlated with a life cycle in total darkness. (See biology section).

Secondly, the species adds the family Mesoveliidae to the disharmonic Hawaiian endemic biota. We believe that the other mesoveliids, Mesovelia amoena Uhler and M. mulsanti White, reported herein, are recent immigrants, introduced as a result of man's activities.

We believe this endemic species is derived from a progenitor similar to Speovelia maritima Esaki known from sea caves and rocky coasts on the east coast of Japan (Esaki, 1929). Ocean currents would seem to have provided a suitable dispersal agent, west to east, across the north Pacific.

Pahoehoe flows entering the ocean sometimes provide a sea cave at the ocean end of a lava tube which could have been colonized by a sea cave adapted progenitor which then migrated landwards through the lava tube and evolved into a lava tube adapted species.

There is an abundance of sea caves in Hawaii and these have been little explored for native biota. But it is possible that a close troglophilic relative of S. sp. may yet be found under such situations. Former sea caves, now found at varying distances inland are known to harbor endemic biota. For example, several species of aquatic amphipods are found in Waianapanapa Caves, E. Maui, a coastal lava tube (Barnard, in press). Similarly, drowned lava tubes at or near sea level with anchialine environments contain a remarkable endemic biota (Maciolek and

Brock, 1974).

Of the two remaining species of Mesoveliidae, only Mesovelia amoena Uhler has been found in caves. In Hawaii it is usually found along the margins of brackish and fresh water ponds and streams on Oahu and Kauai. In Waikanaloa Wet Cave and Limestone Quarry Cave, island of Kauai, it lives on the walls at and just above the water margin, apparently preying on drowned arthropods washed up along the edge.

A third species, M. mulsanti White, has not yet been found in any cave situation.

When Vandel published his monograph on Biospeleology in 1965, he did not consider any of the cave dwelling Heteroptera known up to that time to be troglobitic. Subsequently, a monograph of the emesine Reduviidae (Wygodzinsky, 1966) and a survey of the Lygaeidae (Scudder et al., 1967) have not changed this viewpoint. A number of true bugs in several other families, especially Leotichiidae, Lestoniidae, Reduviidae, and Cimicidae live in caves, but none of these has apparently become so highly modified as to be obligates of the cave environment (Miller, 1971; Vandel, op. cit.). As with many representatives of island biota and also cave animals elsewhere this remarkable bug can be considered a rare and endangered species. It is with some trepidation then that we make known its existence and the existence of its cave. We hope that elucidating these spectacular examples of insular evolution will engender a better appreciation of the uniqueness and importance of island biota in evolutionary biology.

## KEY TO HAWAIIAN MESOVELIIDAE

1. Head produced, elongate, twice as long as width across eyes; body yellowish, appendages elongate, antennae 1.5 times body length (FIG. 1); rostrum reaching last abdominal segment, first visible abdominal tergite of nymph simple, not bifid (FIG. 2), apterous, troglobitic . . . . . Speovelia sp.

1' Head not elongate, subvertical, much less than twice width across eyes; variously pigmented; appendages not elongate; antennae much less than 1.5 times body length, rostrum not surpassing hind coxae; first visible abdominal tergite of nymph bifid (FIG. 11), apterous, micropterous and macropterous; troglophilic and epigean . . . . . 2

2. Length about 2 mm; front and middle femora without a row of black spines beneath; macropterous specimens lacking a small closed cell at apex of corium (FIG. 10); rostrum extending to apices of hind coxae, troglophilic and epigean . . . . . Mesovelia amoena

2' Length more than 3 mm; front and middle femora armed beneath with a row of black spines; macropterous specimens with 3 closed cells in the hemelytra (FIG. 14); rostrum extending only to hind margins of middle coxae; epigean . . Mesovelia mulsanti

## SPEOVELIA SP. (FIG. 1, 2, 4-8)

### Taxonomic description

Cave mesoveliid: Howarth, 1972:325, FIG. 2 (see REFERENCES)

Speovelia sp.: Howarth, 1973:147-148 (see REFERENCES)

Apterous ♂ (pinned). Color evenly yellowish brown (a black spot on 3rd visible abdominal sternite near outer apices of coxae) covered with short yellowish pubescence, above, beneath, and on appendages, glabrous on sides of head, weakly shining, these areas weakly shagreen; post-antennal portions of head and propleura dull; eyes small, red, weakly pigmented, situated an eye's diameter from the prothorax.

Body elongate-ovoid (FIG. 1).

Head: extremely elongate for the family, approximating that of a hydrometrid, longer than thorax (head: thorax = 85:55), vertex convex, widening to antennal

bases then abruptly narrower, 2 shallow, parallel furrows running from base to a point halfway between 1st and 2nd pairs of trichobothria. Tylus and jugum clothed with prominent anteriorly directed bristles. Trichobothria situated as follows: 1 pair in line connecting bases of antennae 1, 2nd pair equidistant from eyes and antennal bases, 3rd pair on posterior margin of vertex, the latter most prominent. Diameter of eyes subequal to thickness of 1st antennal segment, comprised of about 12 facets. Antenniferous tubercules prominent. Antennae long and slender, antennae I thickest, nowhere swollen, slightly curved outwardly; II shorter than I, and more slender; III and IV very long and slender, very weakly annulate, (proportional lengths of antennal segments 5.5:3.5:8.0:10.0). Rostrum reaching base of 5th visible abdominal sternite (proportional lengths of segments of rostrum, III:IV; 9.5:1.5).

Thorax: dorsal surfaces evenly trapezoidal, anterior and posterior margins straight, concave at middle, sutures between thoracic segments parallel, concave at middle, curving anteriorly towards margins; broadly depressed along middle. Pronotum longest, longer than meso- and metanota together (ratio 3.0:2.5), mesonotum longer than metanotum. Omphalium present.

Legs similar, profemora stoutest, posterior pair longest and most slender; pro- and mesocoxae globose, short, half the length of trapezoidal metacoxae; meso- and metafemora with few weak, spine-like setae along the outer apical margin; tibiae very slender, pro- and mesotibiae dilated at apices, thickened and most pubescent there, subequal to respective femora; metatibia longest, gradually more slender apically, longer than metafemur (ratio 10:7); tarsi 3 segmented, ratio of 1st:2nd:3rd as 1:3:2; arolial structure present, hooked (FIG. 6).

Abdomen: elliptical, lateral margins convexly rounded, lateral margins of tergites weakly carinate; tergites 2-7 subequal in length, 1st 3/4 length of these. Tergite 4 with small median scent pore. Connexiva obliquely erect. First male

genital segment posteriorly produced dorsally but not obscuring 2nd genital segment, its apex evenly concave, the latter with a terminal tuft of setae (FIG. 4), parameres obscured, (those illustrated from a paratopotype (FIG. 5).

Apterous ♀ : Differing from male as follows: abdominal spot lacking; parallel furrows of vertex broader, the furrows more prominent, beset with minute punctures. Rostrum just surpassing middle of 4th visible abdominal sternite. Posterior margin of metathorax straight. Tergites 1 and 8 and 2-7 equal in length. Tergite 8 (1st genital segment) fused with connexivum, tergite not laterally carinate; 2nd dorsal segment represented by a small triangular tergite; ovipositor strongly developed, weakly concave, 2 rows of teeth on each side (FIGS. 7, 8).

Length of body: male, 3.6 mm; female 4.15 mm.

Macropterous forms: Unknown.

Last instar nymph: (alcohol) (FIG. 2)

More hirsute than adult but proportions of appendages, excepting antennae, and their segments about the same. The eyes, on comparison with illustrations of other mesoveliid nymphs (Hoffman, 1932, p. 128) are strikingly reduced but are larger and more strongly pigmented than those of adults. Venter membranous, in contrast to dorsum; dorsum sclerotized on thorax and abdomen as illustrated. Spines on legs and antennae more prominent than on adult.

Length 3.5 mm.

Earlier instars: (alcohol)

Sclerotized as in last instar. Eyes comparatively larger and progressively reduced and less pigmented from earlier instar onwards. Thorax and abdomen more hirsute.

## Distribution

Known only from Kazumura and Kurtistown Caves, Hawaii I.

Holotype ♂ (BISHOP 10,260). HAWAIIAN ISLANDS, Hawaii I., Mountain View, Kazumura Cave, 400 m., 25.VII.1971, dark zone, F. G. Howarth and W. C. Gagné (pinned), allotype ♀, and paratypes 5 ♀, 2 nymphs same data as holotype (nymphs in fluid); paratypes: 1 ♂, 1 nymph (in fluid), same data as holotype except, 22.VII. 1971, 200 m. into dark zone, F. G. Howarth; 2 nymphs (in fluid), same data as holotype except, 300 m., 25.VII.1971; 1 ♀ (pinned), same data except, 27.IV.1972; 4 ♂, 1 ♀, (pinned) same data except, 395 m., 6-7.XII.1972, F. G. Howarth and W. C. Gagne; 1 nymph (in fluid), same data except, 300 m., 8.XII.1972, Station 38; 1 ♂, 2 nymphs (in fluid), same data as holotype except, 400 m., 11.III.1973, F. G. Howarth; several exuviae (in fluid), same data as type except, 8.XII.1972; 2 ♂, 1 ♀, same data except, 1.II.1974 (all preceding specimens in BISHOP); 6 ♂, 2 nymphs (in fluid), same data as type except, 408 m., 11.III.1973, M. Polhemus, W. C. Gagne, and F. G. Howarth (J. Polhemus collection).

Other material examined: 1 ♂ (collected dead), many exuvial fragments, Hawaii I., Kurtistown, Kurtistown Cave, 168 m.,18.II.1974, dark zone, F. G. Howarth.

## Etymology and Remarks

An Hawaiian word for lava cave is 'a'a'a, geological structures used extensively by the ancient Hawaiians for shelter, food storage, and for burial of persons of high social rank.

In China and Miller's (1959) keys to the families of the Heteroptera, this bizarre bug would key to the Hydrometridae which it superficially resembles but for the presence of the scent gland in the center of the 4th visible abdominal tergite, not between the tergites, as in the hydrometrids. The elongate head contributes to this deceptive appearance but the eyes are basally, not mesally, situated. The eye size and pigmentation are extremely variable. H. L. Carson (pers. comm.), geneticist at the University of Hawaii, informs us that insect eyes

are tied via supergenes to adaptive characteristics, and in cavernicoles will vary tremendously both in size, pigmentation, and in some cases, will be entirely lacking on one side or another. All these characteristics have been observed.

Until this time Speovelia was monotypic. The type of the genus, S. maritima, occurs on the east coast of Japan. The general habitus and size of the 2 species are similar. We attribute the specific differences to those associated with troglobitic existence of S. sp. (See TABLE 1). Otherwise, the male genitalia and associated segments are similar, the greatest difference seen in the configuration of the head and the 8th sternite (FIG. 3, 4). Polhemus (in corr.) considers these differences sufficient to erect a new genus for S. sp. Since he is contemplating a generic revision of the family we will defer erecting a new genus at this time.

S. maritima has been found in sea caves on the east coast of Japan and in crevices in cliffs just above the wave zone along rocky coasts, while S. sp. has been found only in lava caves on the island of Hawaii.

## Biology

Habitat.--Speovelia sp. is known only from Kazumura and Kurtistown Lava Tubes. Both of these large caves are near the currently active southeast rift zone of Kilauea Volcano. This limited distribution on the cavernous island of Hawaii is unexplained. The bug is not known to occur in similar but smaller caves at 200 m or at 900 m elevation in the same area. Most of the biological observations have been made in Kazumura Lava Tube, specifically near 400 m elevation. In Kurtistown Lava Tube at 168 m elevation a dead ♂ and many exuviae were found deep within the cave (more than 200 m from the entrance) on smooth wet glazed lava walls and ceiling. These fragments were all associated with a thin white "moldy" slime.

Kazumura Lava Tube is the longest known continuous lava tube in the world (Howarth, in prep.), with approximately 10 km of surveyed passage and with still unexplored portions. The cave slopes gently between 250 m and 450 m in elevation.

TABLE 1. Comparison table of Speovelia maritima and S. sp.

| | S. sp. | S. maritima |
|---|---|---|
| Habitat | lava cave, wet walls, dark zone | sea coast, sea caves, wet walls, deep twilight zone, and cracks above waves along rocky coast |
| Habit | omnivorous? | omnivorous |
| Biology | troglobitic | troglophilic |
| Body pubescence | strongly developed | strongly developed |
| Eye | (not functional) reduced, depigmented | reduced |
| Head | elongate (FIG. 1) | normal |
| Ovipositor | strongly developed, weakly concave | strongly developed, weakly concave |
| Pigmentation | virtually none | some loss |
| Appendages | much produced | comparatively long and slender |
| ♂ 8th abdominal sternite | concave (FIG. 4) | bifid (FIG. 3) |

All of the 15 known skylights (Howarth, 1973) were apparently formed while the lava was still flowing in the system. Most are characteristically offset on upper levels.

The upslope 6 km of passage alternates between high narrow meandering passage, usually keyhole shaped in cross section, as much as 8 m high by 4 m wide, and low tunnel-like passages 2-3 m in diameter. There are a few large rooms, approximately 60 m long, 10 m high and 9 m wide. The overburden (thickness of the ceiling rock) is shallow, between 1 m at some skylights in high passages and perhaps 7 m in lower level tunnels. The downslope cave trends toward a bigger and deeper passage. The overburden approaches 15 m in places.

The solidified lava stream forms the floor surface of the cave and varies from smooth pahoehoe to a very rough clinkery aa. Piles of spalling blocks are common. There is no organic detritus or soil on the floor except for a thin layer beneath some of the skylights.

The age of the cave is not known but must be less than 20,000 years, since the lava flow covers the 20,000 year old Pahala ash. The lack of soil on the cave floor is significant and indicates youth. As a first approximation, the cave may be 1000-2000 years old and possibly younger.

The cave underlies a windward boggy savanna dominated by 5-10 m endemic Metrosideros collina trees interspersed with the matting, indigenous fern, Dicronopteris linearis. The savanna, at least in part, has been disturbed by fire and subdivision development within the last two decades. The more disturbed areas have been variously invaded by exotic shrubs and bunch grasses.

Tree roots, principally M. collina, occur scattered throughout the shallow cave passage and are occasionally found in thick patches. Dead roots hang in many places and very few dead roots lie on the floor. Such debris break down rapidly and wash into cracks or vesicles in the floor. These roots, both living and dead,

supply the primary energy source for the cave ecosystem.

The high rainfall (3800 mm/year) and the boggy nature of the ground surface supply a constant ceiling drip which maintains the saturated atmosphere and damp or wet surfaces in the cave. There are occasional puddles on glazed surfaces of the floor, but usually the water percolates rapidly into the cracks and sponge-like vesicles of the lava. A very much heavier drip has been noted during rainy periods.

The air and water temperatures of the cave near the main entrance have both ranged between 18.5°C and 20°C during the 2 years of periodic observations. The close agreement between air and water temperatures implies near saturation. The high volume of ceiling drip may account for much of the variation in temperature, that is, the temperature of the cave approximates the temperature of percolating water. The skylights, which are between 1000 and 2000 m apart, also allow air movement by chimney effect, but the effect of this exchange on temperature and humidity in the cave is insignificant due to the small size of the skylights and their great distance apart. The temperature is 1°C warmer in the downslope passage of the cave.

Food web.--A preliminary food web for Kazumura Lava Tube was presented by Howarth, 1973. More than 35 species of invertebrates have been collected in the cave. At least 1/3 of these may be accidentals, that is, they are probably unable to survive underground. These blunder into the dark zone from the surface or migrate in through cracks along roots. Once in the dark zone they have little chance of finding the surface again and some fall prey to cave predators. There are also a large number of troglophiles, both native and introduced species, living in the cave.

Associated biota.--Most interesting are the true cave animals or troglobites. There are 6 troglobitic arthropods known from Kazumura Cave. Only one species, an

undescribed earwig (Dermaptera), is so far known only from this cave. The 4 other species, Oliarius polyphemus Fennah (Homoptera), Lycosa howarthi Gerstch (Araneae), Caconemobius sp. (Orthoptera), and Dimerogonus sp. (Diplopoda), are widespread in similar caves on the island of Hawaii.

An unknown slime, possibly a fungus growing on organic material percolating into the cave, occurs on the walls in wetter areas, and is not necessarily associated with tree roots. This is usually a white or pinkish mold-like growth which covers a clear or milky white opaque slime. The slime may be up to 3 mm thick. The larval tracks of an endemic troglophilic tipulid, Limonia sp. nr. jacobus, are very common and conspicuous in this slime. In a few locations usually near dead roots a different rubbery gelatinous dark brown slime occurs, and is possibly formed from colloidal lignins from decaying roots. It is deposited as microgours (tiny cup-like formations) from water running down the wall. This slime can be 2 cm thick in places and the microgours, which hold water, are up to 1 cm in diameter.

Distribution within caves.--S. sp. is found only in the dark zone and is most commonly associated with both types of slimes described above. It is only occasionally found in passages without any slime. Possibly the bug feeds on organisms living in the slime or may be found there because other environmental conditions are more favorable.

Nymphs and adults of S. sp. are most commonly found on vertical damp or wet wall surfaces and in cracks and small irregularities in the wall and ceiling. Occasionally they are found on the floor of the passage. Specimens are usually seen singly and appear never to be gregarious. Exuviae are found in the same situations, though more commonly on the ceiling, where as many as 20 cast skins have been noted in 2-3 $m^2$ of ceiling, with none or few noted in similar situations nearby.

Population.--The first 600 m of passage have been thoroughly searched on several occasions and many specimens collected. As many as 17 individuals have been

counted in this passage on one trip. During the trip in March, 1973, only 7 adult specimens and several nymphs were seen in this passage and all of the adults were males. Perhaps males disperse more readily than females.

Behavior.--Individuals exhibit slow and deliberate movement when not disturbed. They appear to carefully move one leg at a time. When disturbed by weak air movement or heat they display slow negative reaction. When touched the insects nervously run rapidly. They show no reaction whatever to light or to shadows and are probably blind.

Food habits.--Feeding by S. sp. has not been observed in the cave and its food habits remain unknown in nature. On December 8, 1972, one of us (W. C. G.) observed a bug "stalk" a cave millipede (Dimerogonus sp.). It was apparent that the bug was following the millipede. However, after 5 minutes the bug was not seen to feed on the millipede and stopped "stalking."

On 2 occasions specimens have been brought back to Honolulu by one of us (F. G. H.) for observation in snap cap vials or shell vials containing dextrose-agar slants. They were offered a variety of living and dead insects, small earthworms and a snail. Actual feeding was observed only twice. In both instances a fresh killed small vinegar fly (Drosophila sp.) was offered and feeding commenced within 30 and 50 minutes respectively. In both cases the bug held its body high off the substrate and directed its proboscis nearly $90^{o}$ from the longitudinal axis of its body and penetrated the abdomen of the fly. When the bug was disturbed by moving the vial slightly it stopped feeding, walked away, and cleaned its antennae and proboscis. Within a few minutes after cessation of the minor disturbance the bug returned to feeding.

There were at least 5 other instances of apparent feeding as noted by the presence of a dark food spot in the distended abdomen. In 4 cases the prey was freshly killed Drosophila, and once feeding occurred on a small tettigoniid

grasshopper that was dead for 3 days.

On several occasions a specimen in the vial with agar slant exhibited possible feeding behavior. The proboscis was directed a little posterior of vertical and probed deeply into the agar. Whether it was drinking or probing for potential prey is not known.

Four starved individuals lived for 14-22 days and 5 bugs which had fed at least once lived for 25-55 days in captivity. The comparatively large connexivum allows the abdomen to expand greatly during feeding. This is possibly an adaptation for a large meal followed by starvation. A few individuals with greatly distended abdomens have been found in the cave.

The captives were never observed to feed on living prey. Indeed, the observations indicate that it is not likely that S. sp. feeds on mobile prey. It stealthily stalks up to potential prey and when the prey moves even slightly the bug nervously runs off. Even 2 or more individuals kept in a 30 ml shell vial would agitate each other unnaturally.

In the cave S. sp. may prey on animals living in the slime with which it is associated, or on dead cavernicoles, especially O. polyphemus and Caconemobius sp., which have been observed on the cave walls. It may also feed on the accidentals which die in the cave.

Comparative feeding and reproductive habits.--Dr. Hashimoto sent (in corr., Hashimoto and Howarth, 22 May, 1972) a brief summary of the observations of Drs. Tokunaga and Aoki on Speovelia maritima in Japan. S. maritima has been reared in the laboratory; however the food habits in nature are unknown. It is a blood sucker on small insects and also moribund larger insects. It also takes juices from fruits. Hoffman (1932) reared the North American species of Mesovelia on freshly killed insects. Most mesoveliids are semiaquatic and able to capture and feed on insects that are trapped or drowned on the water surfaces.

No observations on the mating behavior of S. sp. have been made, and the details of the life cycle are unknown. However, the generations overlap, as adults and larger nymphs have been found throughout the year. For S. maritima the overwintering adults become active in April. Copulation and oviposition occur in June. Copulation takes place within 60 seconds and is usually repeated several times per day. In the laboratory eggs are laid on filter paper. The egg has been described by Cobben (1968). The nymph transforms into adult in September. Other details on its habit and biotic associates are given by Yuasa (1929).

## SPEOVELIA MARITIMA ESAKI (FIG. 3)

Speovelia maritima Esaki, 1929:343. -- Yuasa, 1929:346. -- Howarth, 1972:325. -- Cobben, 1968:54, 253, 336.

Material examined: 2 ♂, JAPAN, Tanegashima I., Kumano, 27.V.1960, H. Hashimoto; 1 ♀, (original label lost), data fide Hashimoto, JAPAN, Izu Peninsula, Shimoda, Shizuoka Prefecture, H. Hashimoto.

This species extends north-south from Shimoda on Honshu Island to Yakushima Island in the northern Ryukyu Islands (Hashimoto, pers. comm.).

## MESOVELIA AMOENA UHLER (FIGS. 9-13)

Mesovelia amoena Uhler, 1894. Proc. Zool. Soc. Lond.:218.

### Taxonomic description

Apterous ♀ (pinned) (FIG. 9). Color brownish-black with luteus markings, portions of head and thorax grey pulverulent. Head luteus above, paler below, apex of tylus, genae and posterior area of vertex pulverulent, darker about trichobothria on tylus. Eyes reddish brown. Antennae I luteus, II-IV brownish-black. Rostrum yellowish. Dorsal yellowish area of thorax narrowing posteriorly, equal to interocular area on prothorax then narrowing again to ¼ this width on metathorax and on

to 1st abdominal tergite, becoming darker laterally, collar black; prothorax with pair of black, shallow median impressions; metathorax otherwise grey pulverulent, laterally brownish-black with paler plural stripe, intersegmental areas narrowly pulverulent, wider about spiracle and ostiole; acetabular caps white. Legs luteus, paler below and towards bases of femora. Coalescent abdominal tergites I-IV brownish-black, II luteus at antero-lateral angles; tergite V brownish-black medially, remainder pulverulent; tergites VI-VII, medially luteus with darker borders; tergites VIII-IX, luteus; lateral connexiva II-VII luteus inside borders with adjacent segment; remainder brownish-black; venter luteus, darker anteriorly.

Head strongly declivious, length, when viewed with abdomen on horizontal plane, 5/8th of head width across eyes, ratio of frontal length (viewed from top of eyes to tip of tylus) to head width across eyes, 5:4. Eyes not emarginate; eye width ½ interocular width. Rostrum almost reaching apices of metacoxae.

Ratio of antennae I to IV as 3:2:6:5; almost as long as body 16:17. Antennae I with 3 strong setae interiorly beyond middle, II with a row of stronger setae. Pronotum convex dorsally with shallow depression on either side of median line, widest posteriorly, a little more than half as long on median line as greatest width, ratio 6.5:10; hind margin evenly convex, anterior angles shallowly rounded. Pro- and mesonota subequal in length on median line, ratio 2.5:2.4, hind margin of former straight for a distance equalling the interocular space, then margins curving anteriorly. Metanotum about ½ length of mesonotum, 1.25:2.5, hind margins shallowly convex to abdominal margin, then curving posteriorly.

Legs simple, femora lacking distinct spines ventrally, meso- and metafemora each with 2, and profemora with single, spine-like setae near anterior apices. Protibiae unarmed, mesotibiae with basal spine-like setae and several rows on metatibiae. Tarsal ratio 0.5:1.75, a pair of spine-like protruberances at bases of claws (FIG. 12).

Abdomen widest across segment V, wider than thorax, ratio 5.5:4, coalescent tergites I-IV more inflated than remainder, flattened on anterolateral angles. Ovipositor as illustrated (FIG. 13). Length 2.15 mm.

Male unknown (in Hawaii).

Last instar nymph (FIG. 11): (alcohol) Differing from ♀ as follows: more sparsely and coarsely hirsute; lacking variegate pattern; spines on legs longer and more prominent; 1st visible abdominal tergite bifid. Length 1.7 mm.

Distribution: Kauai and Oahu Islands (introduced - new State record).

## Material examined

Hawaiian Islands: Kauai I., Haena, Waikanaloa Cave, 13.VIII.1971, F. G. Howarth, twilight zone on walls above water; 1 apterus ♀, 1 nymph, same data, from moss covered wall, twilight zone 30 m from entrance; 6 apterus ♀, 3 nymphs, same data, deep twilight zone 45 m from entrance, on wall and in debris on floor of small side passage; 12 apterus ♀, same data, 15 m elevation, 3.X.1972, on wall in dark zone, W. C. Gagné; 14 apterus ♀, 3 nymphs, Kauai I., Koloa, Limestone Quarry Cave, sea level, 5.VI.1973, on small pool and rafts of debris in dark zone, F. G. Howarth and R. C. A. Rice; 1 alate ♀ (FIG. 10), 1 nymph, Oahu I., Waimea River, 15 m elevation, 2.X.1971, W. C. Gagné, sifted from leaf debris stranded on boulders in river; 1 brachypterus ♀, 1 apterus ♀, Oahu I., Salt Lake (Aliapaakai), 7.VI.1973, on mud at shore, W. C. Gagné; 3 apterus ♀, Oahu I., Palolo Stream, upper plunge pool, 300 m, 10.I.1974, F. G. Howarth and E. L. Bousfield.

## Remarks

This undoubtedly immigrant species has not been previously reported in the Hawaiian Islands. It is of apparently recent introduction for it was not encountered by Williams (1936-1944) in his thorough analysis of the aquatic and semiaquatic insects of the Hawaiian Islands. Martin Polhemus (pers. comm.) collected females

and nymphs of this species on Oahu I., in a small stream near Waialua in March, 1973.

It is perplexing that no males have yet been found in Hawaii. It is possible that the Hawaiian population is parthenogenetic, an unprecedented phenomenon for the Heteroptera. It is bisexual in North America. Such a situation pertains with a ceratopogonid midge, Culicoides bermudensis Williams, which is bisexual on the east coast of North America, but is parthogenetic (and autogenous) on Bermuda (Williams, 1961).

The fusion of the first two visible tergites may be a sexual character, to judge from examination of other Mesovelia species from the Pacific Basin. By comparison with these, M. amoena is a very dark species with a unique arrangement of paler margins on the dorsum.

At the mouth of Waikanaloa Cave M. amoena was associated with the ubiquitous immigrant veliid, Microvelia vagans White, but the latter species avoided the darker zones.

## MESOVELIA MULSANTI WHITE (FIG. 14)

Mesovelia mulsanti White, 1879, Trans. Ent. Soc. Lond.:268. -- Williams, 1944:188. -- Zimmerman, 1948:226.

This immigrant species is widespread in the Western Hemisphere. In Hawaii it was recorded from Oahu, mostly in lowland situations, but is nowhere as ubiquitous as the immigrant veliid, Microvelia vagans White. In the laboratory it preyed on the immigrant hebrid, Merragata hebroides White (Williams, 1944). It has been found here only in epigean situations.

New island record: Hawaii I., Kau District, Kaalualu Bay, 18.XI.1973, S. L. Montgomery, pond near sea level.

## MESOVELIA SP.

A single nymph, differing from any of those of the above was collected on Kauai. The data are: Wainiha Beach, 19.I.1973, F. G. Howarth, under log at edge of river, sea level. The antennal proportions differ from similar sized nymphs of M. amoena from the Waikanaloa Wet Cave and the antennal segments are more thickened. The nymph is predominantly yellowish rather than blackish.

## ACKNOWLEDGEMENTS

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Mr. John Polhemus of Englewood, Colorado confirmed the identity of M. amoena and sent comparative notes on S. sp. from his Mesoveliidae of the World project. His brother, Martin also kindly furnished locality data on M. amoena on Oahu.

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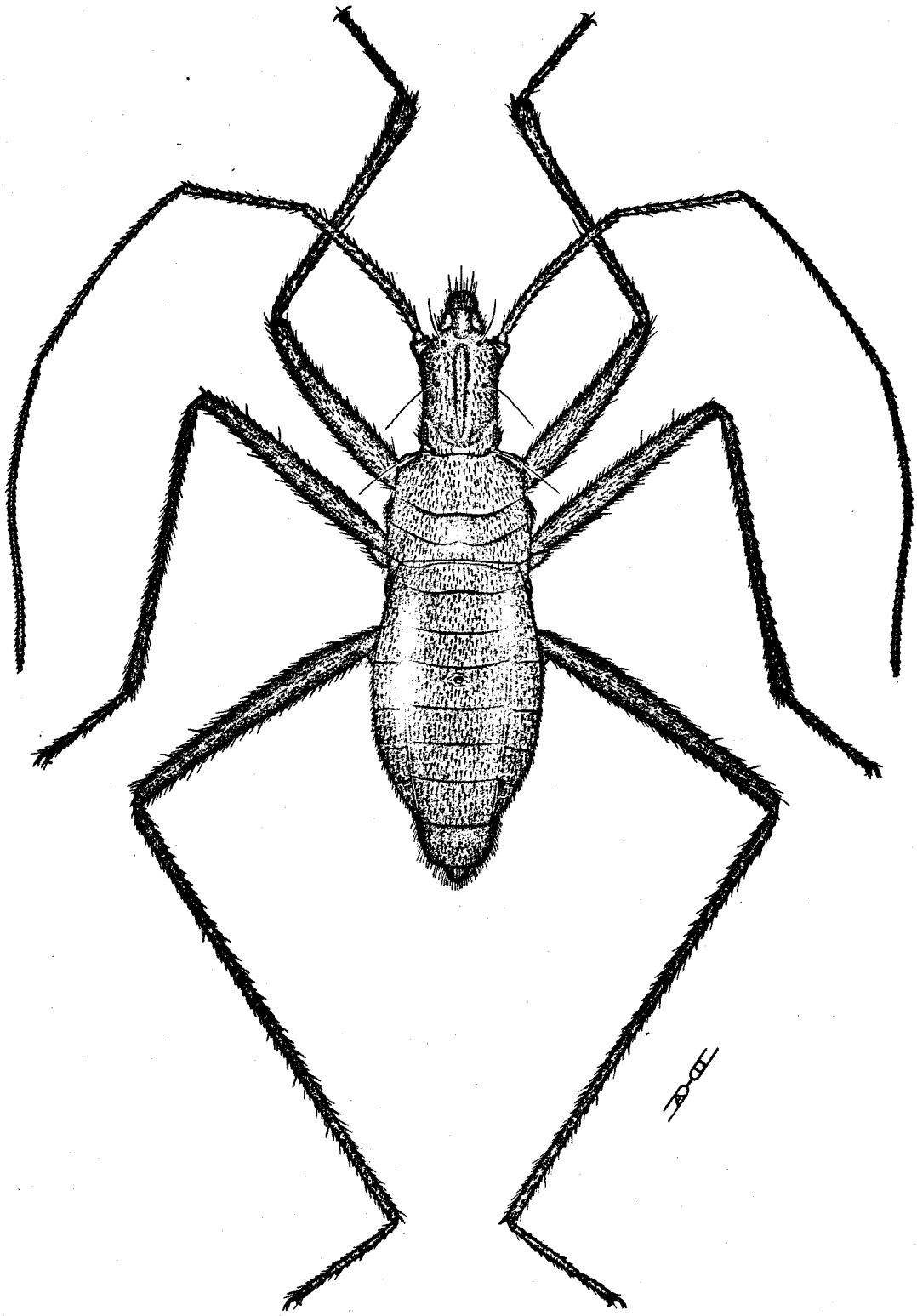


FIG. 1. Speovelia sp., ♂: dorsal view.

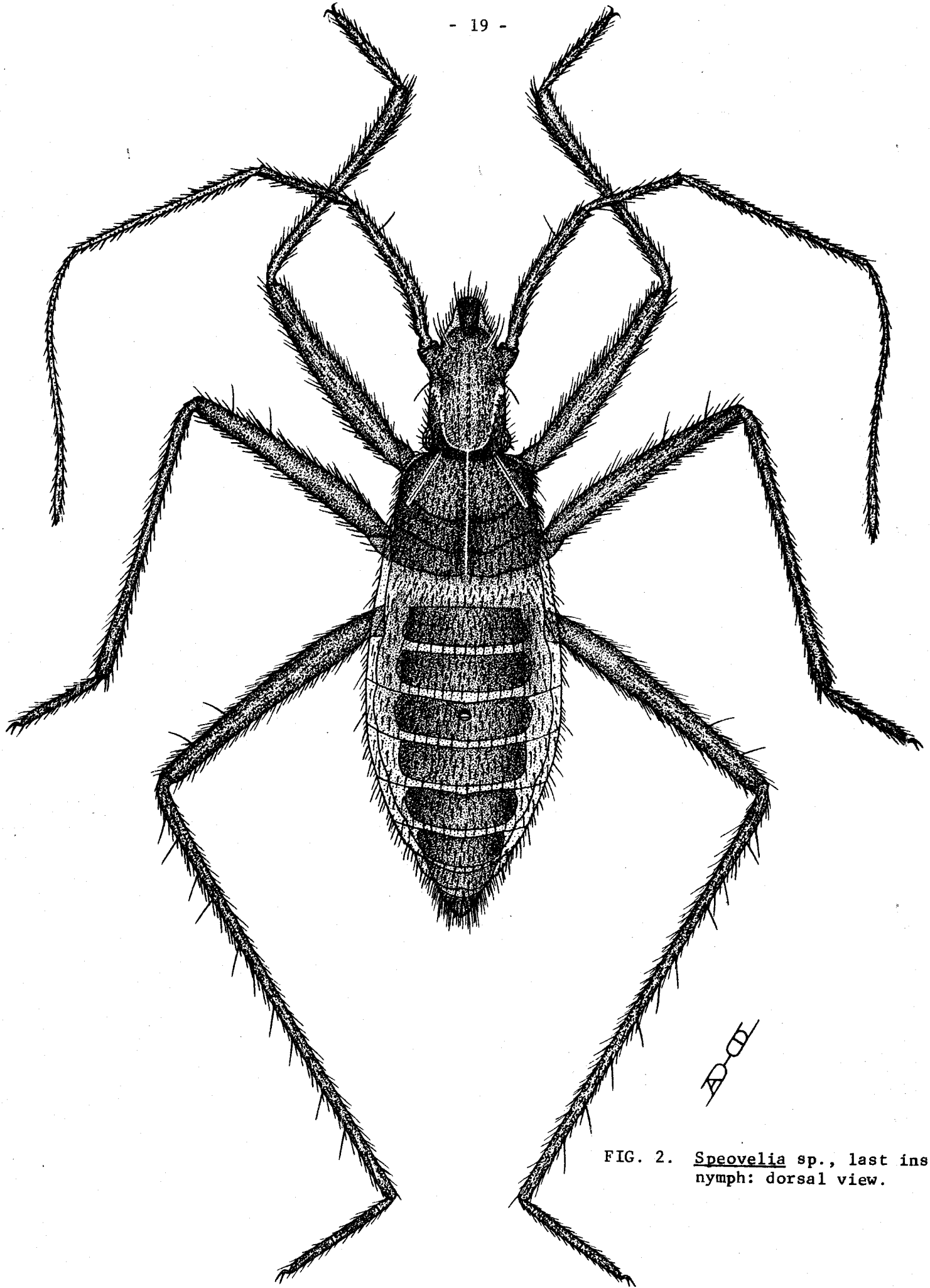
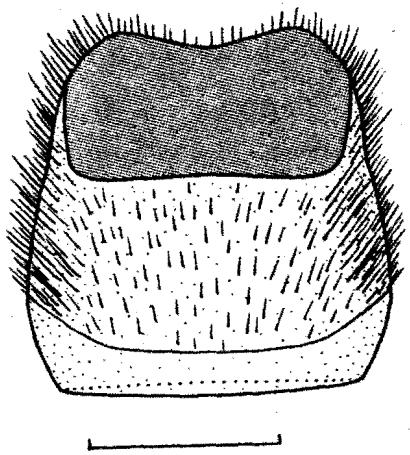


FIG. 2. Speovelia sp., last instar nymph: dorsal view.



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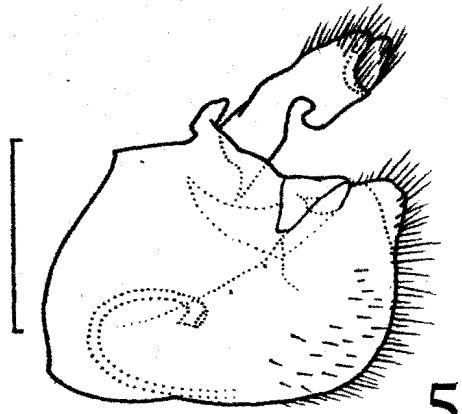

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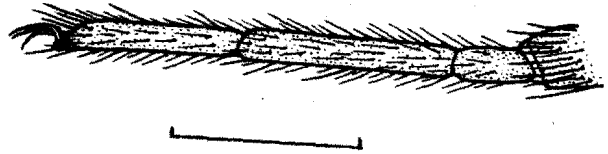

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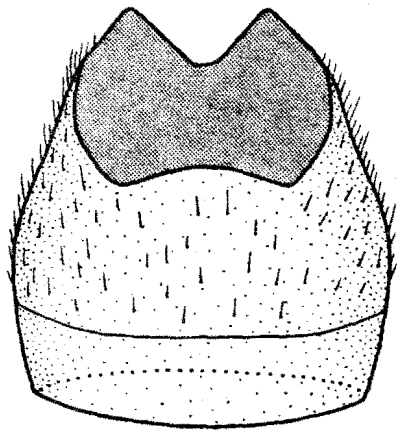

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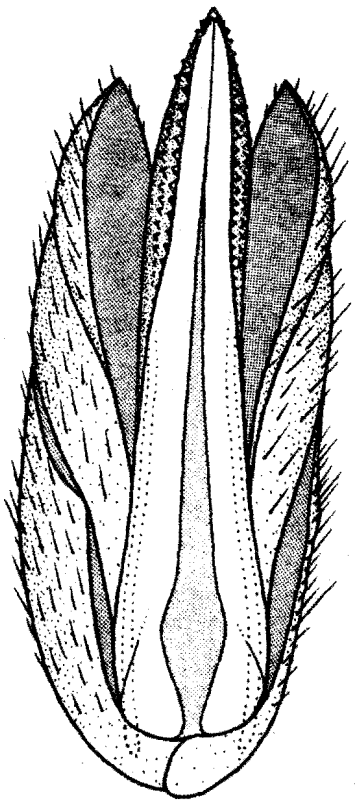

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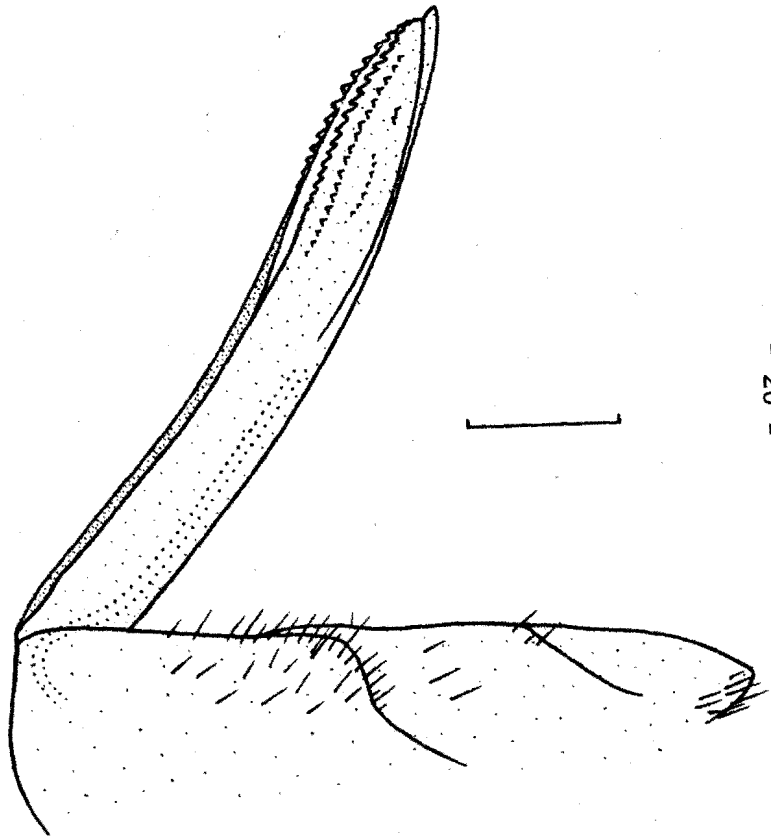

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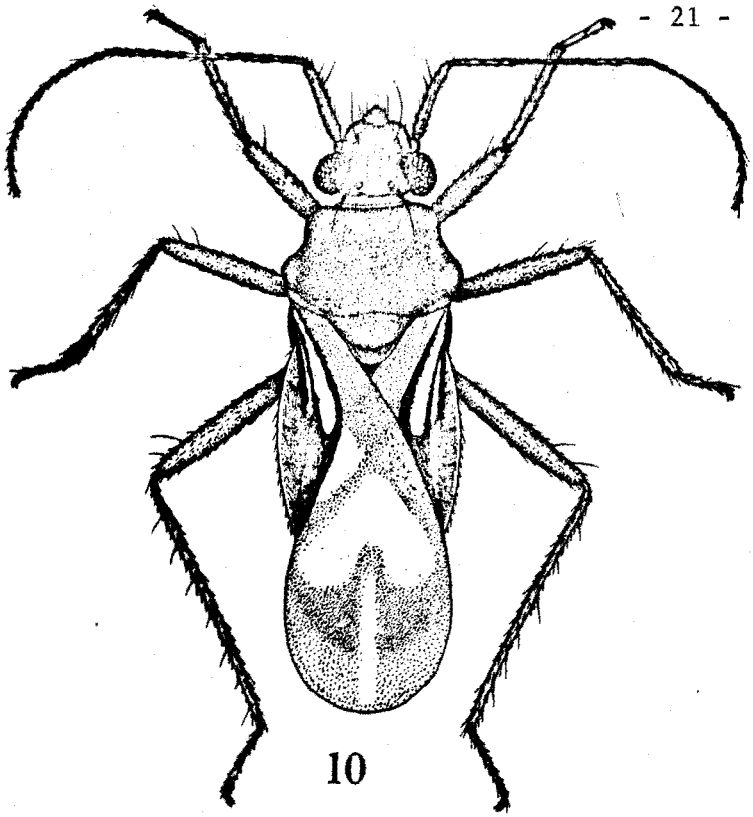
FIGS. 3-8. Speovelia maritima Esaki, ♂: 3, 8th abdominal segment, dorsal view. FIG. 4-6. S. sp., ♂: 4, 8th abdominal segment, dorsal view; 5, 9th abdominal segment, lateral view; 6, metatarsi, lateral view. FIG. 7-8. S. sp., ♀: 7, ovipositor ventral view; 8, same, lateral view. (Scale equals 0.25 mm)



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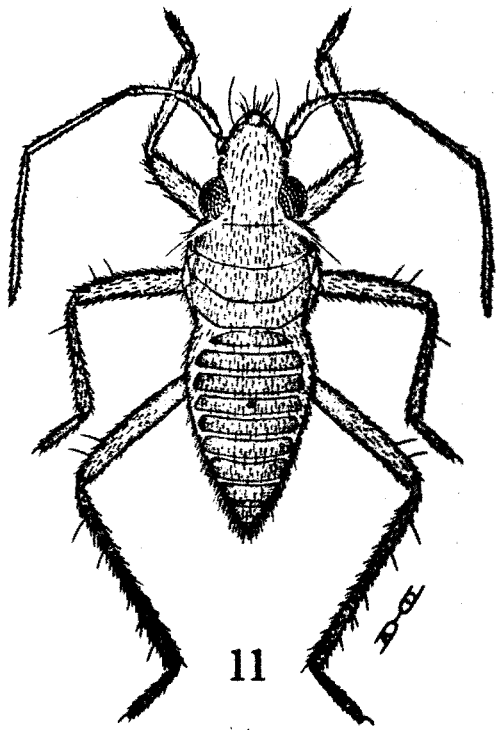

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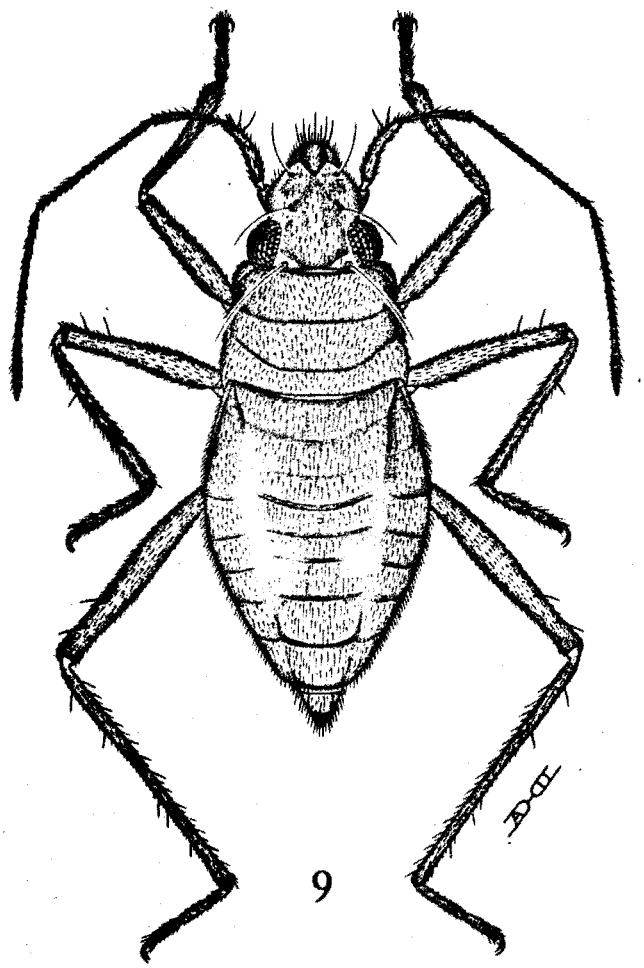

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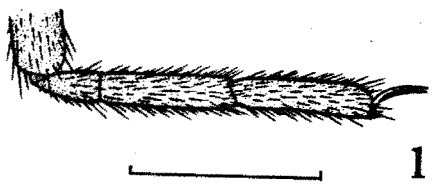

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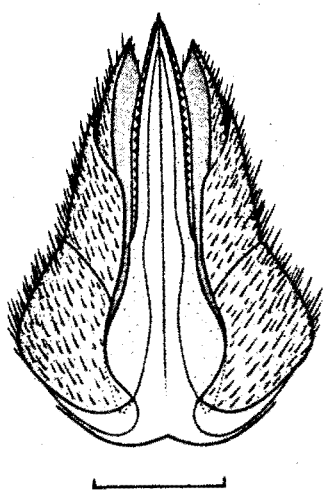

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FIG. 9-13. Mesovelia amoena Uhler: 9, apterus ♀, dorsal view; 10, alate ♀, dorsal view; 11, 5th instar nymph, dorsal view; 12, ♀ metatarsi, lateral view; 13, ovipositor, ventral view. (Scale equals 0.2 mm)

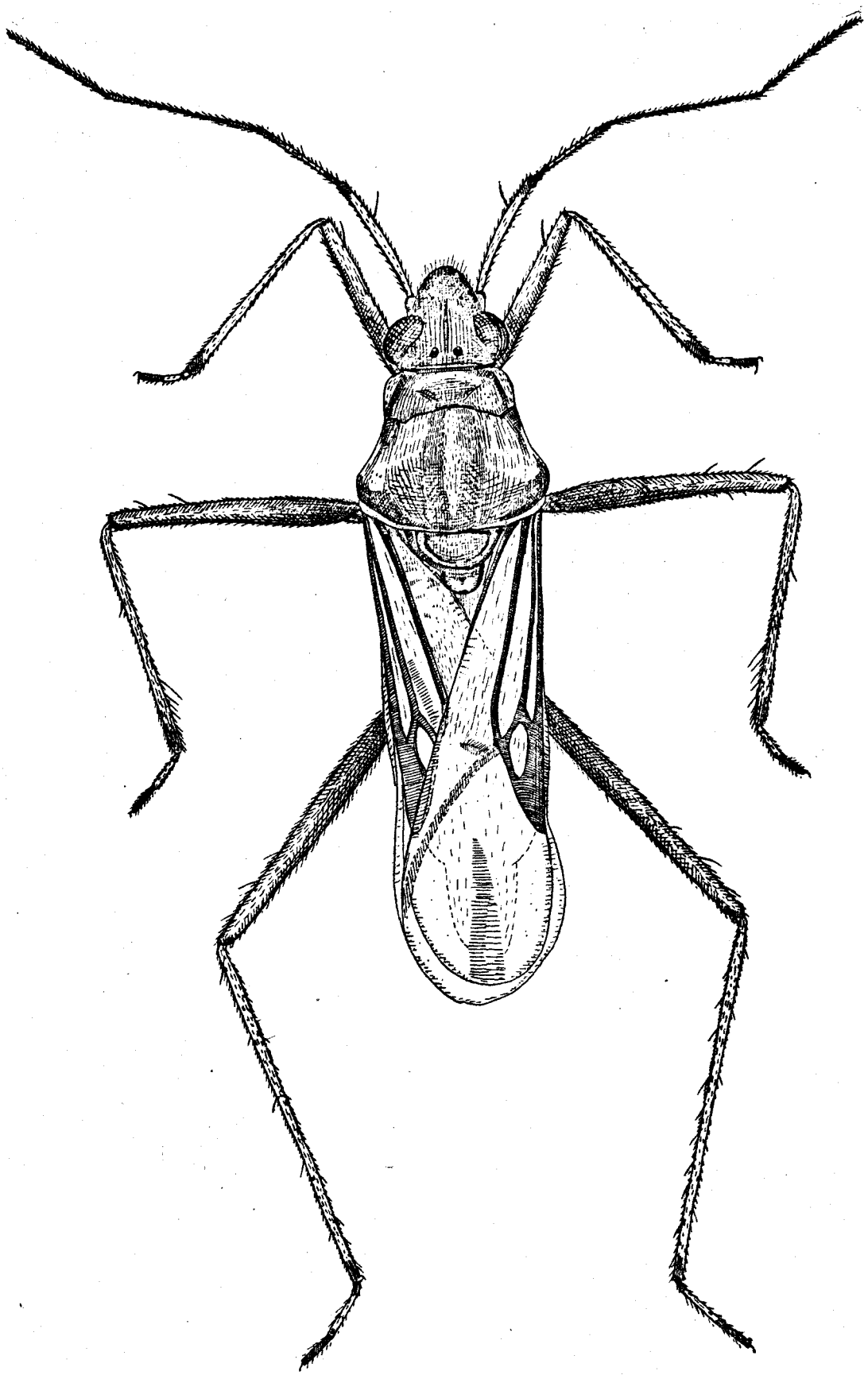

FIG. 14. Mesovelia mulsanti White, ♂, alate: dorsal view.

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